(12) UK Patent Application (19) GB (11) 2 085 748 A

(21) Application No 8130805
(22) Date of filing 13 Oct 1981
(30) Priority data
(31) 8034330
(32) 24 Oct 1980
(33) United Kingdom (GB)
(43) Application published
6 May 1982
(51) INT CL³
B01J 8/44
(52) Domestic classification
B1F C1B
(56) Documents cited
GB 1536654
GB 868043
(58) Field of search
B1F
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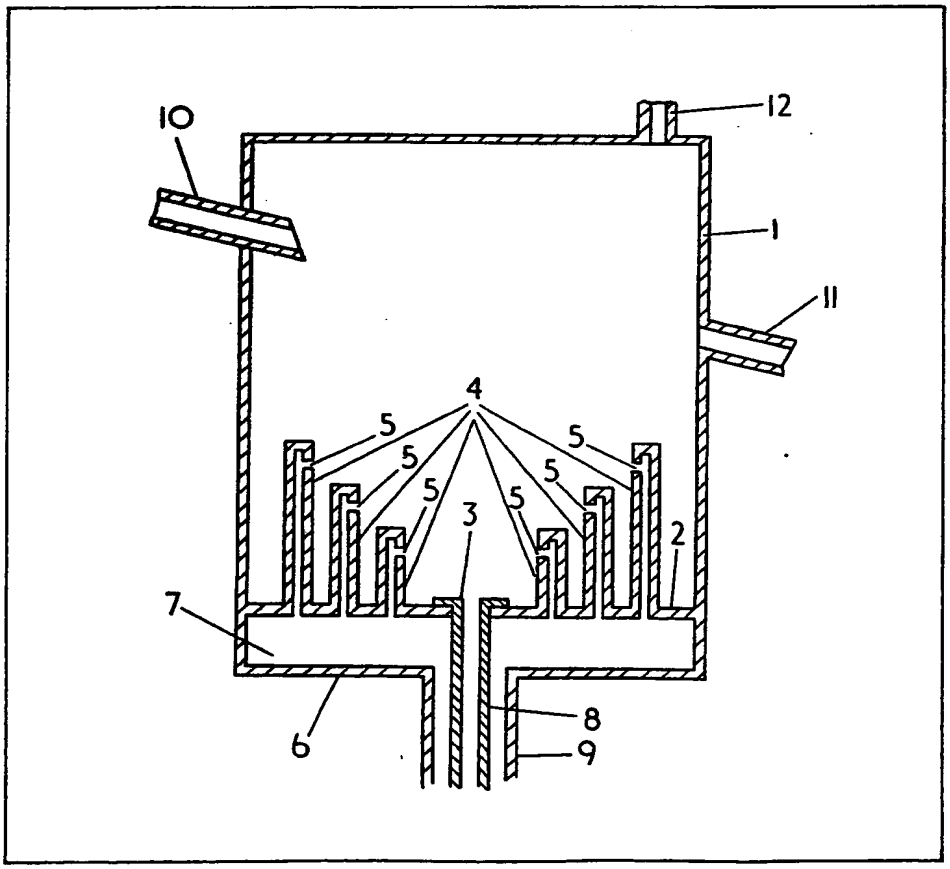
(54) Fluidised bed apparatus

(57) Fluidised bed apparatus for the combustion or gasification of large size coal or fuel of low calorific value comprises a container (1) divided into an upper section and a lower plenum chamber (7) by a horizontal plate (2), from which standpipes (4) for introducing fluidising gas extend upwardly with their upper ends arranged to lie on an inclined plane or planes, e.g. an inverted cone, and a spout inlet (3) located on the plate below the upper ends of the standpipes to introduce spouting gas. Particles from the bed may be removed at or near the spout inlet (3).



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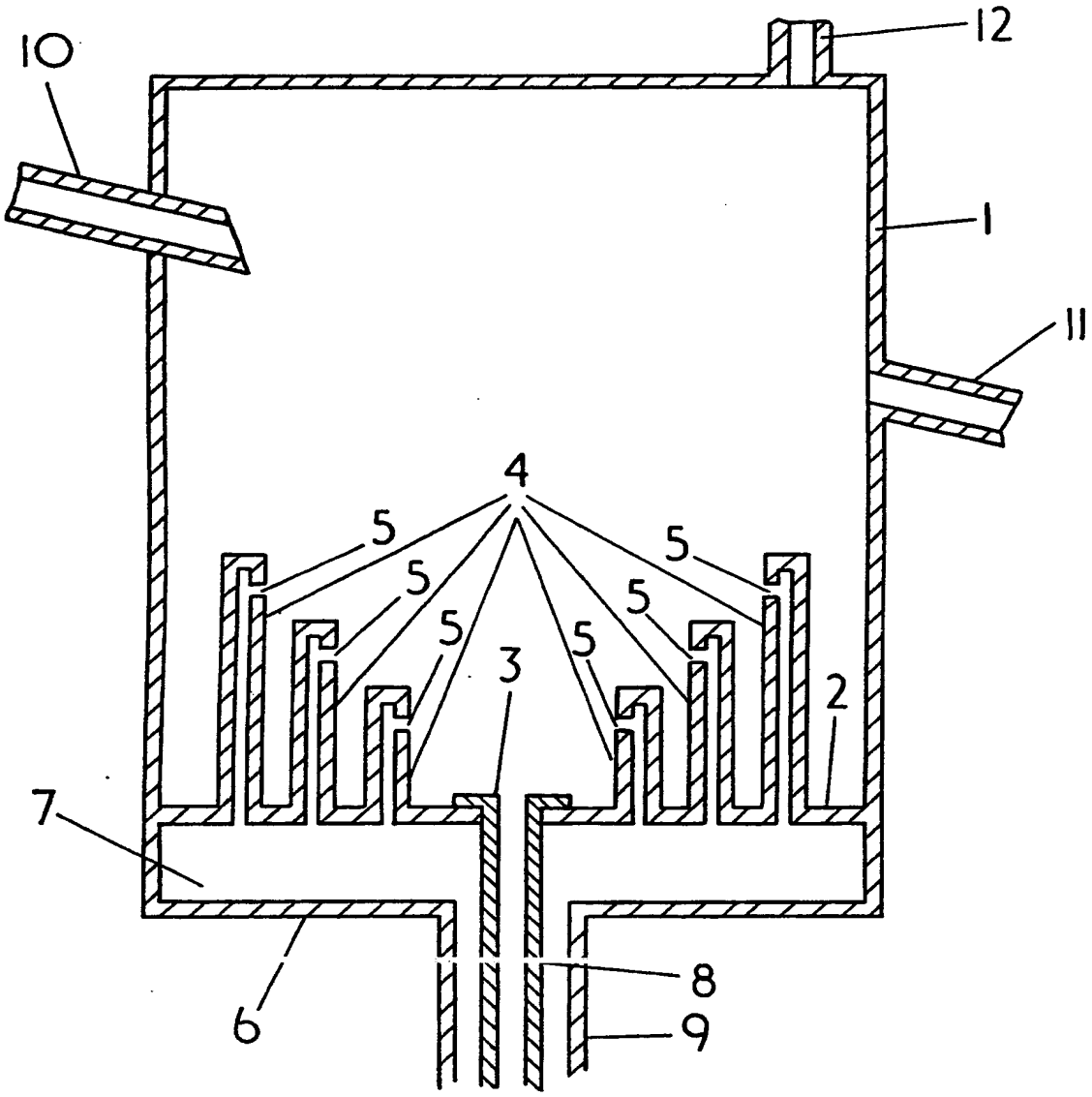

SPECIFICATION

Fluidised bed apparatus

The present invention relates to a fluidised bed apparatus and in particular, but not exclusively, to an apparatus for combustion or gasification of large size coal or solid fuel of low calorific value.

Many processes using fluidised bed technology in the combustion or gasification of coal are known. However, at fluidising velocities presently used, only small size ash coals can be handled. If large lumps of high ash coal are used, many problems arise. During combustion or gasification, the majority of the shale ash particles will remain at or near their original size and therefore cannot be supported in the bed by the fluidising gas and settle onto the base of the apparatus. The lumps obstruct the fluidising gas inlets, thereby interfering with the efficient fluidising of the bed.

Moreover, the lumps are still able to react with the incoming fluidising gas. This will cause some of the ash in the coal to form clinker which will further obstruct the gas inlets.

It has been proposed, for instance by Jequier, Longchambon and Van de Putte (J. Inst. Fuel. *33* 239 pp 584-591, December 1960) to gasify coal fines in a spouted/fluidised bed having an angled base. Their apparatus is designed to burn only fine coal and to allow agglomerated material such as ash and agglomerated coal particles to be removed from the apparatus through the spout in order to prevent interference with the fluidisation of the particles. However, this also resulted in the loss of useful fuel in the agglomerated coal particles removed. The angled base plate was susceptible to increased distortion by differential heating and therefore had to be made from expensive materials. Although the system could be used for combustion of fine coal, as long as a fines recycling system was included, it could not be used with large size coal because the particles would defluidise and remain on the plate. As the spout used would not be able to recycle the large lumps severe segregation would occur in the lower region and if an ash discharge port were used in this region to reduce segregation, a significant proportion of fuel would be lost.

There have also been proposals to burn or gasify large size coal or low calorific value fuel in a spouted bed apparatus. For instance, British Patent No. 1 521 983 describes an apparatus in which combustible material is fed into an apparatus in a flow of spouting gas. The flow of gas forms an inverted conical zone extending over the whole of the base of the apparatus. The fuel is burnt in the zone, but if it is too large to be maintained in the spout, the fuel will fall into a stagnant zone below the cone. In one example, incipient fluidisation is used to aid movement of defluidised particles into a stagnant zone below the cone. However a major proportion of the total air supply is delivered through the spout, thereby losing many of the benefits of fluidisation, such as good gas/solids mixing and heat transfer. A further disadvantage of this apparatus is that heat transfer from a spouted bed to a surface immersed therein is poor, thus making it difficult to extract useful energy from the combustion of fuel in the apparatus.

It is an object of the present invention to provide an apparatus for the combustion or gasification of large size coal or low calorific value fuel which at least in part overcomes the disadvantages of previously proposed apparatuses.

Therefore, according to the present invention, apparatus for the combustion or gasification of large size coal or low calorific value fuel comprises:—

a container having a substantially horizontal plate dividing it into an upper section for containing a bed of fluidised particles and a lower section;

a plurality of standpipes extending upwardly from the plate with their upper ends arranged on an inclined plane, for introducing a flow of fluidising gas to the upper section; and

a spout inlet located on the plate below the lowest of the upper ends of the standpipes, for introducing a flow of spounting gas to the upper section.

Preferably, the lower section is formed into a plenum chamber through which the flow of fluidising gas is directed to the standpipes.

Preferably, the spout inlet comprises a nozzle located on the plate for directing the flow of spouting gas.

The standpipes may be formed integrally with the plate. However, preferably they are removably mounted on the plate for easy replacement, repair or inspection. Advantageously the flow of fluidising gas emerges from the upper ends of the standpipes at least partly in a horizontal direction and is directed to assist the flow of particles towards the spout.

Preferably, the inclined plane is an inverted conical or pyramidal plane, and the spout nozzle is located at or near its apex.

Conveniently although not necessarily, the standpipes are arranged in sets symmetrically around the spout inlet, and the length of the standpipes in each set is proportional to its distance from the spout. Thus in the case of a conical plane, the standpipes will be arranged in concentric circles around the spout.

The apparatus preferably includes a particle removal system. This may comprise a port in the supper section of the container above the longest of the standpipes. In this case the particles removed will comprise a sample of all the particles in the bed. Removal by this method will ensure that particles of all sizes have the same mean residence in the bed. Alternatively, the removal system may comprise a tube at or near the spout inlet. This will preferentially remove larger segregating particles and this will ensure that the average size of the particles in the bed is not significantly increased. The latter system will be of advantage if the particles fed to the apparatus have great tendency to agglomerate or clinker. This will allow the removal of agglomerated or clinkered particles.

Conveniently, the region below the upper ends of the standpipes will be filled with the bed material used during normal running of the apparatus. The particles in this region will remain static and unaffected by the spouting of fluidising gas flows and will form an inclined surface below the level of the

upper ends of the standpipes.

The apparatus according to the present invention may also include conventional blowers, for supplying fluidising and spouting gas flows, feed means, for introducing material to the bed, gas treatment systems, for cleaning up gases given off from the bed, and heat exchangers immersed in the bed.

The apparatus is envisaged of being of particular but not exclusive use in the combustion of large size coal or low calorific value fuel, such as discard from colliery washery. Such material may comprise up to 90% w/w ash and have a size up to 25mm.

The advantages of the present apparatus are as follows. The flow of gas needed to maintain all the particles in a fluidised or spouted state is significantly less than would be needed to fluidise them. This reduces the elutriation of fine particles. There is very good gas/solids mixing due to the recycling of large particles through the action of the spout. This means that all sizes of particles can be efficiently combusted or gasified. Since the particles are mainly in a fluidised state it is possible to obtain good heat transfer to surfaces immersed therein, thereby enabling efficient extraction of energy from the combustion of the fuel. Since there is a quantity of material between the bed and the plate, the plate is thermally insulated from the bed and thus can be made of cheaper material.

The present invention will now be described by way of example only with reference to the accompanying drawing which shows a cross-sectional side view of apparatus according to the invention.

Referring now to the drawing, apparatus according to the invention comprises a cylindrical container 1 having in its lower portion a flat base plate 2. A spout nozzle 3 is formed in the centre of the base plate 2 and a plurality of standpipes 4 are arranged in sets in concentric circles around the spout nozzle 3, the length of each set of standpipes 4 being proportional to the distance from the spout nozzle 3. The upper ends of the standpipes 4 are therefore arranged on an inverted conical plane. Gas outlets 5 are formed in the upper ends of the standpipes 4 to project gas approximately horizontally into the upper section of the container 1. The outlets 5 are formed only in the side of each standpipe facing towards the spout nozzle 3, thereby directing the flow of particles towards the spout.

A second plate 6 is located below the base plate 2 to form a plenum chamber 7 below the base plate 2. A pipe 8 is connected to the spout nozzle 3 and a second pipe 9 is connected to the plenum chamber 7. A fuel feed 10, bed material removal port 11 and gas outlet port 12 are also located in the container 1.

In use, gas is introduced to the spout nozzle 3 at such a rate that it forms a spout or jet capable of transporting the largest particles to be maintained in the bed, for instance of a size of about 25mm. Gas is also introduced to the plenum chamber 7 at such a rate as to give a superficial fluidising velocity in the upper section of the container 1 of about 1.7 m/s.

A quantity of coarse sand, conveniently having a size range from 0.5 to 3.0 mm, is introduced to the upper section. This will form a static region below and a fluidised particle bed above the upper ends of the standpipes 4. The bed of particles is then heated to about 800°C, for instance by use of gas torches. Solid fuel of low calorific value, such as coal washery discard, containing about 10% w/w carbon and having a size up to 25mm is introduced to the bed through fuel feed 10. Combustion of the carbon in the fuel will maintain the bed at 800°C, and useful heat may be extracted from the bed, for instance by immersing heat exchange tubes therein.

The superficial fluidising velocity will not be sufficient to maintain large particles in the fluidised bed. These will therefore settle out onto the non-fluidised sand particles and will move down towards the spout nozzle 3. The flow of gas from the spout nozzle 3 will entrain these particles and return them to the bed. Since there is no plate on which large particles can settle, there is no opportunity for them to obstruct to any great extent the gas outlets 5, therefore enabling the bed to remain well fluidised.

As the fuel contains a high quantity of ash, it is necessary either continuously or intermittently, to remove material from the bed to prevent build up of material. This is achieved by use of port 11 in conventional manner.

Thus the present invention provides apparatus in which even large size low calorific value fuel may be efficiently combusted.

CLAIMS

1. Apparatus for the combustion or gasification of large size coal or low calorific value fuel comprising:—

a container having a substantially horizontal plate dividing it into an upper section for containing a bed of fluidised particles and a lower section;

a plurality of standpipes extending upwardly from the plate with their upper ends arranged on an inclined plane, for introducing a flow of fluidising gas to the upper section; and

a spout inlet located on the plane below the lowest of the upper ends of the standpipes, for introducing a flow of spouting gas to the upper section.

2. Apparatus according to claim 1, wherein the lower section is formed into a plenum chamber through which the flow of fluidising gas is directed to the standpipes.

3. Apparatus according to either one of claims 1 and 2, wherein the spout inlet comprises a nozzle located on the plate.

4. Apparatus according to any one of the preceding claims, wherein the standpipes are removably mounted on the plate.

5. Apparatus according to any one of the preceding claims, wherein the flow of gas emerging from the standpipes in use is directed to assist the flow of particles towards the spout.

6. Apparatus according to any one of the preceding claims, wherein the standpipes are arranged symmetrically around the spout inlet.

7. Apparatus according to any one of the preceding claims, and including a particle removal system.

8. Apparatus according to claim 7, wherein the particle removal system includes a tube at or near the spout inlet.

9. Apparatus according to any one of the preceding claims, and including a quantity of particles fil-

ling the region below the upper ends of the standpipes.

10. Apparatus for the combustion or gasification of large size coal or low calorific value fuel, substantially as hereinbefore described with reference to the accompanying drawing.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1982.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.